

SECTION 1204

SUBMERSIBLE PUMPS

1204.0100 GENERAL

1204.0101 Description of Work. The work under this Section shall consist of furnishing all labor, materials, equipment, and appurtenances required for the installation and testing of submersible pumping unit assemblies, all in accordance with the details shown on the plans and specifications and the requirements of this Section. The pumping unit assembly shall be provided by the pump manufacturer. The pumping unit assembly shall include, but not be limited to:

- Pump
- Pump discharge head and bowl assembly
- Motor
- Column pipe
- All component parts

It is the intent of this Section to obtain high-efficiency, durable submersible pumps of heavy-duty construction for heavy-duty service capable of pumping water for continuous service or for intermittent service, whichever imposes the most severe service on the pump.

All submersible pumping unit assemblies shall be field tested. Pumps with mechanical defects or not meeting the range of head, capacity characteristics, horsepower, efficiency, and vibration requirements will be rejected after testing and shall be replaced without additional cost to the Owner for furnishing, removal, reinstallation and re-testing. Mechanical defects shall include the following:

- Excessive vibration
- Improper balancing of any rotating parts
- Improper tolerances
- Binding
- Excessive bearing heating
- Defective materials, including materials that do not conform to the specifications
- Improper fitting of parts
- Any other defects that will, in time, damage the pump or unreasonably impair its efficiency

All necessary and required accessory equipment and auxiliaries, whether specifically mentioned in this Section or not, shall be furnished and installed as required for an installation incorporating the highest standards for this type of service. Also included shall be supervisory services during installation and field testing of each unit and instructing the regular operating personnel in the proper care, operation, and maintenance of the equipment.

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1204.0103 Submittals. All submittals shall reference the Tucson Water project plan number.

Submittals shall provide clear and accurate information or they shall be rejected.

Shop drawings shall be submitted for all submersible pumps, in accordance with the provisions of the project specifications and as follows.

(A) Pumping Unit Assembly. Submittals shall furnish shop drawings and literature together with dimensional drawings showing the entire submersible pumping unit assembly. They shall also include detailed specifications of each item of equipment and auxiliary apparatus, as well as the following:

- (1) Complete details of the submersible discharge head
- (2) Dimensioned assembly drawing detailing the entire submersible pumping unit
- (3) Pump make and model
- (4) Number of stages in pump
- (5) Pump bowl material and diameter, including ASTM specification compliance
- (6) Pump bowl bearing material
- (7) Impeller type, material, and diameter
- (8) Pump shaft material and diameter
- (9) Column pipe size and material
- (10) Internal coatings
- (11) Any noteworthy design features

(B) Pump Performance Curve. For each pump to be supplied, submittals shall furnish the actual pump performance curve for both the fully assembled multistage pump and the specific impeller diameter. The catalog curve and all bowl and impeller data shall include:

- (1) Pump head and capacity curve
- (2) Horsepower requirement curve
- (3) Efficiency curve

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- (4) Thrust factor (K) curve
- (5) NPSH curve
- (6) Pump input power
- (7) Impeller lateral
- (8) Recommended impeller setting
- (9) Weights of the pumping unit components

Curves shall show the full recommended range of performance and include shutoff head. This information shall be prepared specifically for the pump proposed. See sample at the end of this Section for required information and proper data plotting. Failure to comply with these requirements will result in rejection of the pump.

(C) Operation and Maintenance Data. Complete operating and maintenance instructions shall be furnished for all included equipment. Maintenance instructions shall include troubleshooting data, full preventative maintenance schedules, and complete spare parts lists with ordering information. Manuals shall be submitted prior to pump testing.

1204.0104 Delivery, Storage, and Handling. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is complete and the unit and equipment are ready for operation.

All equipment and parts must be properly protected against any damage during shipment. Every precaution shall be exercised in handling so as to avoid imposing any strain on any part of the pump and bowl assembly. Equipment shall be stored in accordance with the manufacturer's recommendations.

Factory-assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the Engineer.

The finished surfaces of all exposed flanges shall be protected by wooden or equivalent blank flanges, strongly built and securely bolted thereto.

Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.

No shipment shall be made until written approval of the submersible pumping unit assembly submittals has been received.

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Bearings shall be properly processed to protect them during shipment and installation. If pre-lubricated, anti-friction bearings shall be protected in accordance with the bearing manufacturer's recommendations against formation of rust during a long period of storage while awaiting completion of installation and startup of the machine in which the bearings are used.

If not pre-lubricated, anti-friction bearings shall be properly treated with the application of Exxon Rust-Ban No. 392, or equal, in accordance with the bearing manufacturer's recommendations against formation of rust during a long period of storage while awaiting completion of installation and startup.

1204.0200 PRODUCTS

1204.0201 Materials.

(A) Submersible Pumps. The pumping unit shall be designed and furnished in accordance with the latest Hydraulic Institute and AWWA Standards for submersible turbine pumps as specified herein.

**Table 1204-1
Standards**

Subject	Standard Designation
Submersible Vertical Turbine Pumps	ANSI/AWWA E102-06
Protective Epoxy Interior Coatings for Valves and Hydrants	ANSI/AWWA C550
Steel Structures Painting Council Surface Preparation Specification No. 10	SSPC-SP-10/NACE 2
Suction and Discharge Cases (Flanged and Bolted)	Cast iron ASTM A48 Class 30
Pump Bowl	Cast iron ASTM A48 Class 30
Impellers (Enclosed)	Bronze ASTM B584-876 or type 316 stainless steel
Pump Shaft (Bowl Shaft)	ASTM A582 type 416 stainless steel PSQ
Discharge Case Bearing	ASTM B584-836 or ASTM B505
Suction Case Bearing	ASTM B584-836 or ASTM B505
Intermediate Bowl Bearing(s)	ASTM B584-836 or ASTM B505
Bowl Assembly Bolts, Studs, Nuts	ASTM A276 type 316 stainless steel

All submersible pump components shall conform to the National Sanitation Foundation Standard (NSF) 61, amended as of October 1988, or the latest revision of NSF Standard 61 in force for the State of Arizona.

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- (1) Submersible Pump Bowl Assembly.** Pump bowl housings shall be of close-grained, ASTM A48 Class 30 cast iron with smooth waterways. They shall be free from blow holes, sand holes, and other detrimental defects, and shall be accurately machined and fitted to close tolerances. All bowl bearings—including upper and lower guides, and intermediate bearing—shall be of bronze ASTM B584-836 or ASTM B505.
- (2) Impellers.** Impellers shall be cast bronze ASTM B584-836 or type 316 stainless steel, of enclosed design, and accurately machined to fit the matching faces of the bowls. They shall also be designed for severe sand wear, statically and dynamically balanced, and have non-overloading characteristics. Impellers shall be securely locked to impeller shaft with collets while also remaining easily removable. The castings shall be accurately machined, with vanes carefully finished to ensure smooth passageways. Impellers shall be free of any casting imperfections.
- (3) Diffusers.** Pump bowl assemblies that use diffusers shall furnish either bronze or type 304 stainless steel diffusers compatible with the impellers.
- (4) Strainer.** The suction (inlet) area shall be equipped with a corrosion-resistant stainless steel strainer, ASTM A240, type 304 or 316. The openings on the strainer screen shall not be more than 75 percent of the minimum opening of the water passage through the impeller or the bowl.
- (5) Hardware.** Collets and all hardware shall be stainless steel ASTM A276, type 316 or 416.
- (6) Check Valves.** Pumps shall be equipped with check valves, the outside diameter of which shall not exceed the outside diameter of the pump.
- (7) Cable.** The submersible cable shall be copper with synthetic rubber or plastic insulation and protective cover. The cable shall be suitably supported from the column at several points adequate for the type of cable used with corrosion-resistant clamps. The electrical conductor shall be protected by a corrosion-resistant cable guard where it passes the pump bowls.
- (8) Motor Bracket.** The motor bracket shall have anti-vortex vanes to suppress vortex formation.
- (9) Pump Shaft.** The pump shaft shall be ASTM A582, type 416 stainless steel “pump shaft quality” (PSQ).
- (10) Shaft Coupling.** The shaft coupling shall be ASTM A276, type 410 stainless steel and capable of transmitting the total torque and total thrust of the bowl assembly in either direction of rotation.

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(B) Column Pipe Assembly. Column pipe assembly and the materials used in its manufacture shall comply with the most recent revision of ASTM A53, Grade B unless otherwise specified.

Column pipe assembly is to be in 20 feet lengths (or random lengths) and connected by threaded sleeve type ASTM A108 steel coupling and shall have ANSI B1.20.1 standard tapered pipe threads. Minimum wall thickness on all columns shall be 0.375 inch.

The column piping size shall be such that velocities are between 4 and 10 feet per second.

Column pipe shall be painted inside and out with an NSF/ANSI 61 approved 2-part epoxy.

Prior to installation, the Inspector shall verify certification of the pump column pipe and inspect all NPT threaded couplings.

(C) Pump Discharge Head. The discharge head shall be fabricated of ASTM A234 steel with a surface discharge flange and ASTM A36 steel base plate. The discharge head shall incorporate a long radius elbow welded securely to an ANSI Class 150 flange with sufficient strength and rigidity to carry the suspended weight of the attached column and bowl, motor assembly, cable, and column of water.

The discharge head base plate shall have a cable seal to accommodate the cable size and water level indicator. The discharge flange shall be faced and drilled to match the discharge piping flanges and pressure class. All water passages and wetted parts of the discharge head shall be coated with an NSF/ANSI 61 approved 2-part epoxy paint system.

The discharge head shall have lugs for hoisting capable of supporting at least 3 times the weight of the pump assembly under steady hoisting conditions.

(D) Submersible Electric Motors. The motor shall be of the submersible, squirrel cage induction type designed for continuous duty underwater operation.

The motor shall be a heavy-duty canned (or wet wound) type of NEMA design, and shall be designed with normal starting torque and low starting current for across the line starting.

The motor shall have a service factor of 1.15 and shall not be loaded in excess of its nameplate rating at design condition, nor shall it be loaded in excess of 110 percent of its nameplate rating at any condition from zero to maximum capacity of the pump.

The motor shall be water filled and incorporate a double mechanical seal to restrict foreign matter from entering. Mercury seals will not be accepted.

Motor thrust bearing shall be of ample capacity to carry the weight of all rotating parts plus the hydraulic thrust and shall be an integral part of the driver.

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Motor case windings shall be covered with waterproof, non-aging insulation of high dielectric strength.

Motor temperature shall be rated no higher than the allowable operating temperature of the motor thrust and radial bearings, and in no case shall it exceed the temperature rating of the insulation class used to wind the motor.

The rotor shaft shall be of stainless steel and shall be supported by suitable journal bearings.

The motor must include expansion diaphragm and suitable cable gland. Wire motor leads must be protected by metal shield firmly attached to pump.

The maximum motor diameter and the minimum inside diameter of the well shall be in such relationship that under any operating condition, the water velocity past the motor shall be between 1 and 10 feet per second. For flow velocity conditions other than those recommended above, a shroud may be recommended by the manufacturer. The supplier shall verify motor shroud requirements based on operating flow characteristics provided by the Owner.

1204.0300 EXECUTION

1204.0302 Installation. Installation shall be in strict accordance with the manufacturer's instructions and recommendations, and in accordance with the approved submittals.

Qualified supervisory services—including manufacturer's engineering representatives—shall be provided to ensure the work is done in a manner fully approved by the respective equipment manufacturer. The pump manufacturer's representative shall specifically supervise the installation and alignment of the pump with the driver, grouting, and alignment of the connecting piping. Services of the manufacturer's representatives and training shall be provided when the first pump is started, with follow-up visits upon startup of each subsequent pump.

Connection of piping to pumps shall be done in the Engineer's presence. All piping connections to the pump shall be done without bending and/or twisting the piping to mate with the pump flange connections.

A certificate from the equipment manufacturer shall be submitted stating that installation of their equipment is satisfactory, that the equipment is ready for operation, and that the Owner's operating personnel have been suitably instructed in the operation, lubrication, and care of each unit.

1204.0303 Pumping Unit Requirements. Pumping unit performance criteria shall meet the requirements provided by the project plans and specifications. Each pump shall have a rising head capacity curve for stable pump operation from the minimum head operating point to the shutoff head.

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Where total discharge head (TDH) is referred to in conjunction with the specified discharge requirements, it shall be understood to consist of the sum, in feet, of the static head plus the velocity head at the discharge nozzle of the pump, minus the static head and velocity head at the suction nozzle of the can. Bowl efficiency shall be understood to be based upon total head as just defined.

The pump's horsepower requirements shall be non-overloading everywhere on the curve. Not meeting this requirement—both at the factory and in the field—will be cause for rejection.

1204.0304 Quality Assurance. Quality assurance requirements for submersible pumping unit assemblies are as follows:

- (1) Submersible pumping unit assemblies shall be provided by the pump manufacturer.
- (2) Units specified herein shall be furnished by a single manufacturer. The equipment furnished shall be designed, constructed, and installed to operate satisfactorily when installed as shown on the plans. If the entire pump assembly is not provided by the pump manufacturer, the supplier of the components parts will be required to furnish a written certification stating that the component parts are compatible with the pump head and bowl assembly being provided by the pump manufacturer. The written certification(s) shall be submitted at the same time as the pump curves.
- (3) Pumping unit assemblies shall be manufactured in accordance with the Hydraulic Institute Standards, and as specified herein.
- (4) All submersible pump components shall conform to NSF/ANSI 61 and also comply with the **Reduction of Lead in Drinking Water Act of 2011**.

1204.0305 Testing.

(A) Field Testing. Field tests shall be as necessary to indicate that the submersible pumping unit assemblies conform to the head vs. capacity and horsepower requirements; these tests shall be performed in the Engineer's presence. The Contractor shall provide all manpower, facilities, power, equipment, and expertise to conduct field testing. Requirements are as follows:

- (1) Calibration and Installation.** The Contractor shall provide, calibrate, and install all temporary gauges and meters. He/she shall also make necessary tapped holes in the pipes, and install all temporary piping, layflat, valves, hoses, and wiring required for the field acceptance tests.
- (2) Service Representative, Pump Manufacturer.** The Contractor shall provide the service of a fully qualified, factory-trained service representative of the pump

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manufacturer to inspect the installation, witness the initial startup and testing of the pump, and make adjustments as necessary for proper operation. Provisions will be made for the services of the manufacturer's representative for such periods of time as may be necessary to place the unit in satisfactory operating condition.

(3) Inspection. Prior to testing, all required inspection and adjustments shall be made for the proper operation of the pumps.

(4) Test Data. After all testing is complete, the pump manufacturer's factory-trained service representative shall submit in bound booklet form all pertinent data relating to the pumping unit's installation and operation, including but not limited to:

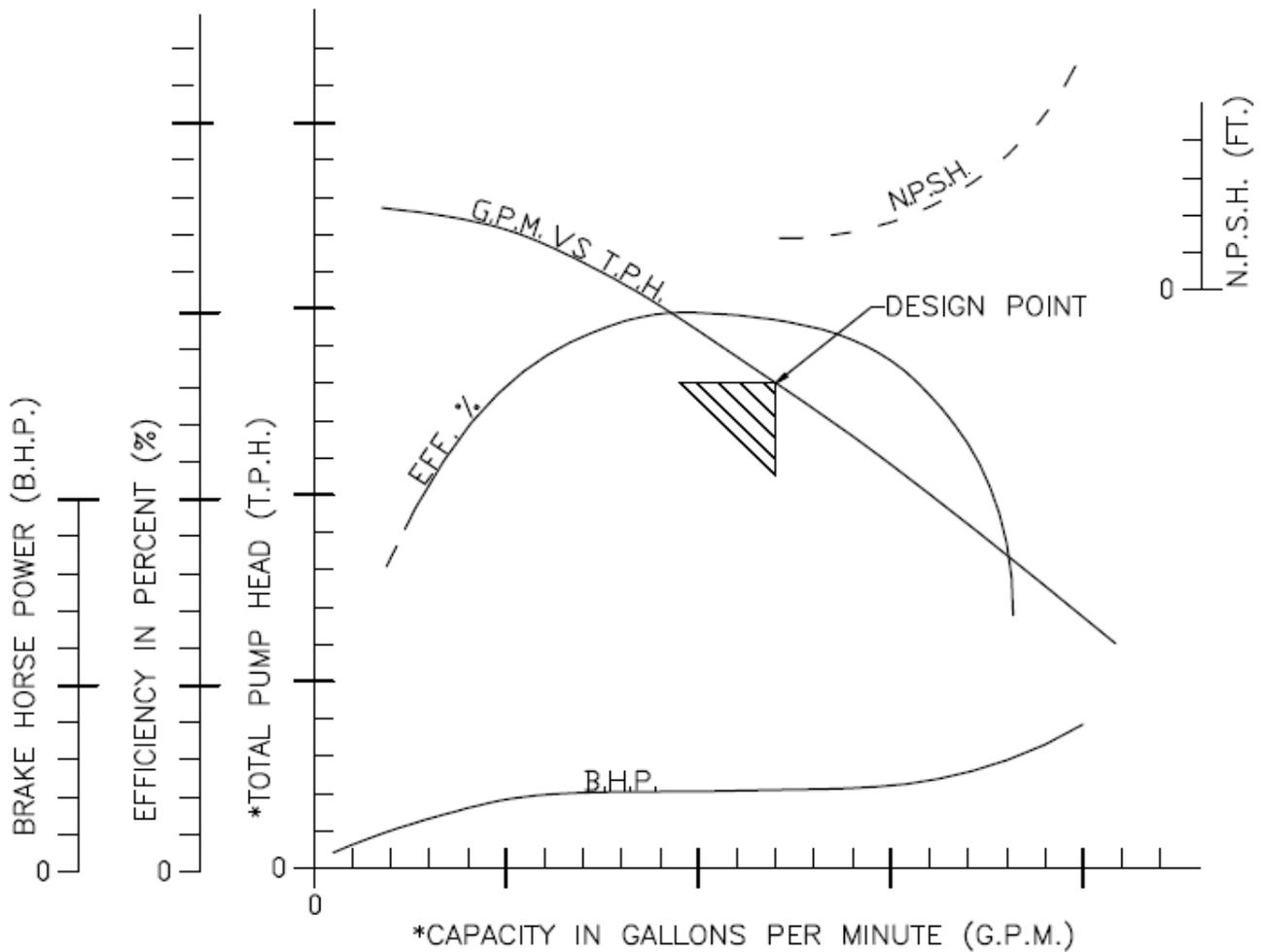
- Pump I.D. and location, technician's name, and date and time tests were performed
- Pump serial number, pump make, pump model, head model, impeller diameter, number of stages, capacity and head at design point, and motor horsepower rating
- Impeller lateral in inches and number of nut turns, in addition to actual impeller setting in inches and number of nut turns

This information shall be included as part of the Operations and Maintenance Manual submittals, and shall be provided prior to final project acceptance.

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SAMPLE PUMP CURVE

- | | | | |
|----------------------|-------|-------------------|-------|
| 1. Manufacturer | _____ | 5. Pump Model No. | _____ |
| 2. Impeller Diameter | _____ | 6. Design GPM | _____ |
| 3. Design Head | _____ | 7. RPM | _____ |
| 4. H.P. | _____ | 8. No. of Stages | _____ |



*Range of capacity (GPM) and Total Pump Head (TPH) shall be of the size to properly demonstrate the pump operational characteristics throughout the entire pumping range of the pump. Failure to do so will result in rejection of the pump curve.